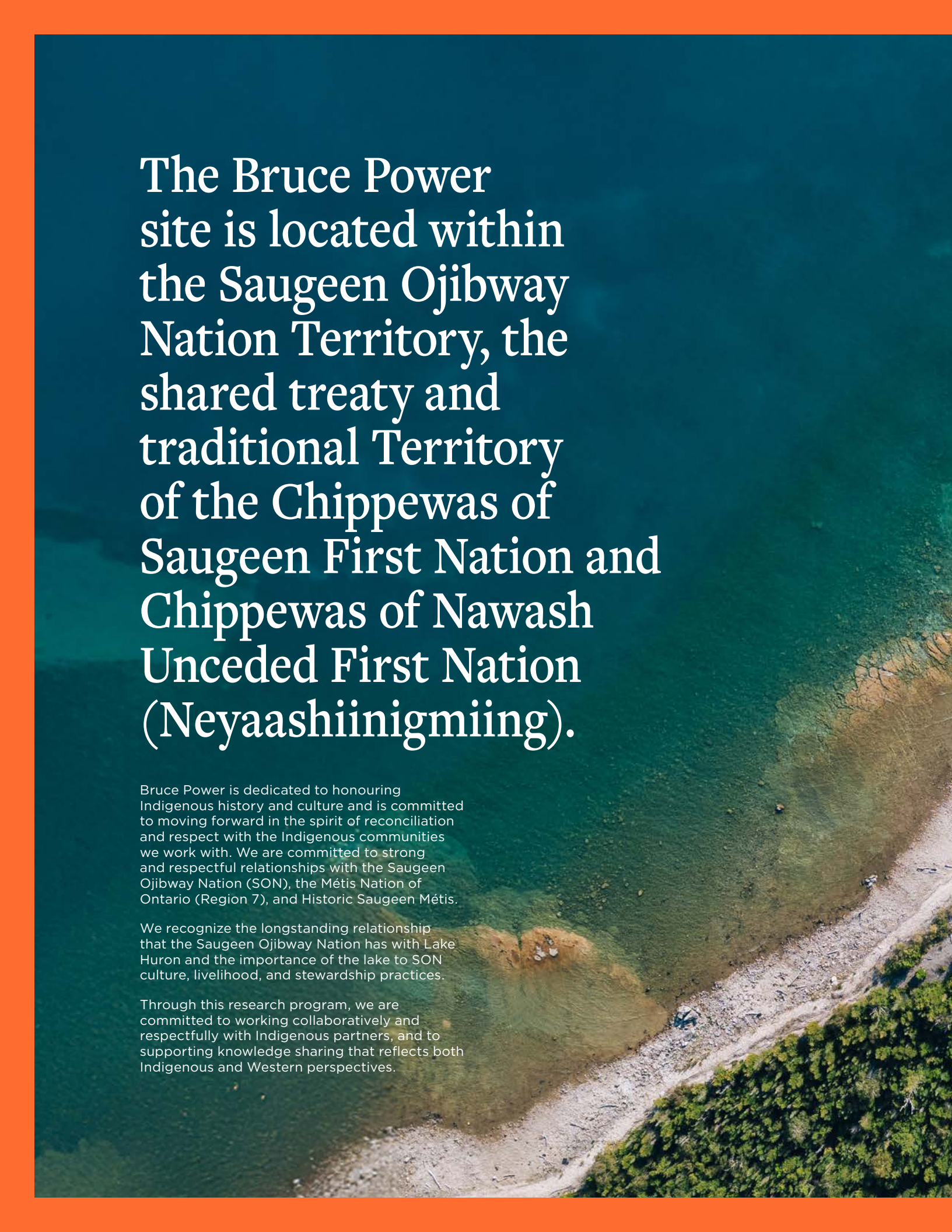




2025 Environment Research Report

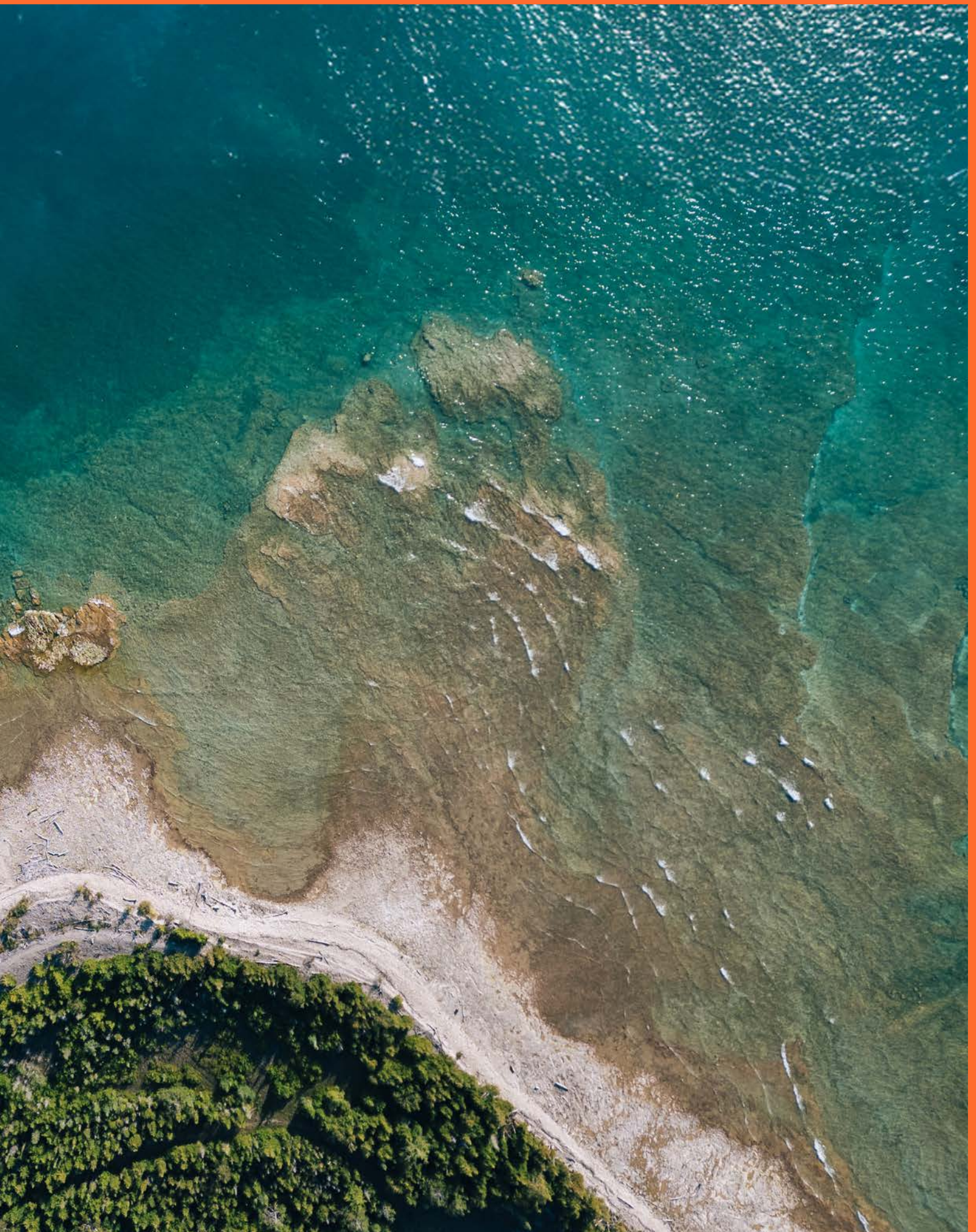
An aerial photograph of a shoreline. The water is a deep green color, transitioning to a lighter green near the shore. A sandy beach runs along the edge of the water, with some small rocks and debris visible. To the right of the beach, a steep, forested hill rises, covered in dense green trees. The overall scene is a natural, undisturbed landscape.

The Bruce Power site is located within the Saugeen Ojibway Nation Territory, the shared treaty and traditional Territory of the Chippewas of Saugeen First Nation and Chippewas of Nawash Unceded First Nation (Neyaashiinigmiing).

Bruce Power is dedicated to honouring Indigenous history and culture and is committed to moving forward in the spirit of reconciliation and respect with the Indigenous communities we work with. We are committed to strong and respectful relationships with the Saugeen Ojibway Nation (SON), the Métis Nation of Ontario (Region 7), and Historic Saugeen Métis.

We recognize the longstanding relationship that the Saugeen Ojibway Nation has with Lake Huron and the importance of the lake to SON culture, livelihood, and stewardship practices.

Through this research program, we are committed to working collaboratively and respectfully with Indigenous partners, and to supporting knowledge sharing that reflects both Indigenous and Western perspectives.



CONTENTS

Introduction	5
Research Timeline	8
Project Updates	12
Paleolimnology: Using Lake Sediments to Track Environmental Change	12
Refining Thermal Benchmarks for Fish	14
Spotter Buoys: Tracking Lake Huron's Water Trends	17
Effects of Sub-Natural Background Radiation Exposure	18
Biological Effects of Radon Gas Exposure	20
Developing Novel Methods in Biodosimetry	21
A Look Ahead to 2026	23
Sentinel Sites and Paleolimnology	23
Trophic Hotspots and Telemetry	23
Nutrient Limitation and Food Web Dynamics	24
Nutrient and Plankton Monitoring for Whitefish Rehabilitation	24
Synthetic Whitefish Egg Entrainment	25
eDNA Monitoring	25
Wave and Ice Modelling	25



ABOUT BRUCE POWER

Bruce Power is an electricity company based in Bruce County, Saugeen Ojibway Nation Territory, Ontario. We are powered by our people. Our 4,200 employees are the foundation of our accomplishments and are proud of the role they play in safely delivering clean, reliable nuclear power to families and businesses across the province and cancer-fighting medical isotopes around the world. Bruce Power has worked hard to build strong roots in Ontario and is committed to protecting the environment and supporting the communities in which we live.



Introduction

Bruce Power has a longstanding commitment to supporting independent, high-quality research that advances understanding of environmental health and sustainability. This work supports informed decision-making, responsible operations, regulatory requirements, and the ongoing protection of Lake Huron and surrounding ecosystems.

Bruce Power's environmental research program brings together expertise from academic researchers in collaboration with universities, Indigenous and community organizations, and government agencies. Several projects also receive support from external funding programs, including the Natural Sciences and Engineering Research Council of Canada and Mitacs. Findings are shared through peer-reviewed

publications, conferences, reports, and open-data platforms, helping to promote transparency and contribute to broader scientific understanding.

From 2020 through 2025, the Nuclear Innovation Institute managed and facilitated a portfolio of environmental and public health research initiatives on Bruce Power's behalf. Bruce Power provided funding, direction, oversight, and subject matter expertise, while the Nuclear Innovation Institute coordinated research activities, supported project delivery, and worked with academic and community collaborators. As of 2026, Bruce Power directly manages this environmental research program, allowing research activities to be more closely integrated with its operations, environmental monitoring, and regulatory planning.

25 years of environmental assessment and learning

Over the past 25 years, Bruce Power, its vendor experts, and its research collaborators have completed environmental assessments, environmental monitoring programs, Environmental Risk Assessments, thermal studies, fisheries investigations, and independent academic research. Together, this work has created an extensive and growing body of information about the Lake Huron shoreline and potential interactions between plant operations and the surrounding environment.

Environmental assessments and regulatory reviews have consistently found no significant adverse environmental effects associated with Bruce Power's operations. Environmental Risk Assessments, which are conducted every five years, bring together information from monitoring programs, thermal studies, and scientific research to evaluate potential risks to the surrounding ecosystem.

This work has improved understanding of fish populations, thermal discharges, nearshore lake conditions, and ecological processes. Studies have found that thermal effects are localized, affecting only a limited portion of available potential fish habitat. No distinct local Whitefish populations have been identified that would be uniquely vulnerable to Bruce Power's operations. Furthermore, studies have concluded that thermal discharges do not pose a significant risk to Whitefish egg survival, development, or hatch timing under the conditions assessed. Findings have been incorporated into regulatory submissions, environmental approvals, operational planning, and long-term monitoring programs.

The research has also reinforced the importance of considering broader influences on Lake Huron, including climate change, invasive species, nutrient dynamics,

natural variability, and the combined effects of multiple environmental pressures. Continued monitoring and research help distinguish potential local effects from broader changes occurring across the lake and identify areas where additional study may be needed.

The research timeline that follows shows how this work has progressed from early environmental assessments and field studies to multi-year ecological investigations, site-specific thermal research, real-time monitoring, and studies of long-term environmental change.

Learning through adaptive management

The 2025 Gizzard Shad event highlighted the importance of maintaining robust environmental monitoring, research, and adaptive management programs capable of identifying, understanding, and responding to unexpected ecological events. While the event did not alter the conclusions of existing environmental assessments or risk assessments, it reinforced the value of continually evaluating new information and investing in ongoing environmental learning.

The event informed both the development of enhanced mitigation measures and the expansion of research and monitoring activities aimed at further strengthening environmental protection and stewardship. Lessons learned have helped shape several initiatives planned for 2026 and beyond, including investigations into fish community dynamics, environmental drivers influencing species distribution and abundance, thermal and habitat interactions, ecosystem resilience, and opportunities to further reduce environmental risk. Together, these efforts support adaptive management, reduce uncertainty, and strengthen environmental decision-making.

RECOGNIZING UNCERTAINTY AND ONGOING LEARNING

Bruce Power acknowledges that SON maintains outstanding concerns regarding potential effects on fish and fish habitat. Addressing these concerns remains an important focus of planned research, monitoring, assessment, and engagement activities in 2026 and beyond.

While the collective findings of environmental assessments, monitoring programs, and research conducted to date support Bruce Power's conclusion that operations are not resulting in significant adverse environmental effects, it is recognized that uncertainty exists in all scientific studies and environmental assessments. These uncertainties help inform and inspire ongoing monitoring, research, and adaptive management to continually strengthen our understanding of the Lake Huron ecosystem and the potential effects of operations.

Bruce Power acknowledges that SON's participation in these programs does not constitute SON's endorsement of Bruce Power's environmental or regulatory conclusions and does not limit SON's independent rights, positions, review, or decision-making.





The environmental data behind our decisions

Environmental protection at Bruce Power is supported by information collected through a range of monitoring, assessment, and research activities. These activities generate several types of environmental data, including:

- Water temperatures measured through thermal loggers and real-time monitoring systems.
- Lake current, wave, and weather data collected through monitoring equipment and offshore buoys.
- Information about fish populations, spawning, entrainment, and impingement.
- Water quality, plankton, and nutrient monitoring data.
- Sediment records used in paleolimnological studies to reconstruct past environmental conditions.
- Radiological and conventional environmental monitoring data.
- Information shared through academic research and research or monitoring undertaken with Indigenous Nations and Communities, where appropriate and in accordance with applicable agreements.

This information is integrated into Environmental Risk Assessments, environmental approvals, regulatory submissions, operational planning, and adaptive environmental management. It helps Bruce Power understand existing conditions, identify long-term trends, evaluate potential risks and cumulative effects, and determine priorities for future monitoring and research.

Environmental conditions are continually changing. Bruce Power continues to invest in monitoring and research to better understand these changes, strengthen the evidence available for future assessments, and adapt environmental protection measures where needed. Bruce Power is also progressing toward a full assessment of cumulative effects as we undergo a federal impact assessment for the proposed Bruce C Project.

About this report

This report has been prepared by Bruce Power. It begins with a high-level overview of 25 years of research, assessment, and monitoring related to interactions with Lake Huron. It then presents the goals, progress, and results of projects undertaken during the 2025 calendar year with Bruce Power funding and coordination by the Nuclear Innovation Institute. Finally, it looks ahead to the expansion of Bruce Power's research and monitoring program, including new projects beginning in 2026.



Research Timeline

This research has progressed from early environmental assessments and field studies to advanced, multi-year ecological investigations and real-time thermal monitoring. Bruce Power's approach reflects a long-term commitment to science-based decision-making, transparency and continuous improvement of understanding.

Bruce Power has used the insights from these programs to inform regulatory compliance and shape long-term environmental monitoring and management strategies. Bruce Power remains committed to deepening its understanding of local ecosystems and striving for the ongoing protection of Lake Huron's aquatic environment.

2000:

Bruce Nuclear Ecological Effects Review (BNEER), by OPG

Estimated Whitefish losses due to impingement and entrainment, concluding no significant effects on spawning due to lack of observed activity in affected areas.



2000-2002:

WINGS, sponsored by OPG

Identified potential spawning habitats near Bruce Power. Emphasized the need for population structure analysis and larval monitoring.

2001-2004:

Units 3&4 Restart Environmental Assessment (EA) and Follow-up Monitoring Program (FUMP)

Round Whitefish selected as Valued Ecosystem Components (VECs). Subsequent interventions incorporated Lake Whitefish in follow-up monitoring programs.

2003-2005:

Technical Working Group (TWG) formed

Aimed to develop long-term monitoring plans, including gillnetting, impingement and entrainment monitoring, and spawning condition surveys. These efforts laid the groundwork for future research and stakeholder engagement.

2000-2005 Foundational Studies and Environmental Assessments

Initial research was driven by regulatory requirements and informed by early engagement with stakeholders, rights holders (SON) and other Indigenous Nations and Communities, whose concerns and knowledge helped shape the focus of these studies.

KEY FINDING Early assessments found no evidence that plant operations were adversely affecting Whitefish spawning habitats and established the foundation for long-term monitoring programs.



Since the early 2000s, Bruce Power has demonstrated environmental leadership through its sustained investment in research to understand the potential impacts of its interactions with the environment, with a strong focus on impacts of thermal discharges on the ecosystems surrounding the site.



2005-2010:

Whitefish Investigations

Annual field studies using gillnets and trap nets documented the presence of spawning-condition Whitefish. Studies were integrated into the Units 1&2 Refurbishment EA Follow-Up Monitoring Program (FUMP).

Population Level Environmental Risk Assessment (Conexus), sponsored by Bruce Power, conducted by the University of Guelph

Aimed to develop population models to assess the cumulative impacts of thermal, chemical and radiological stressors. Findings confirmed that while Whitefish were present near Bruce Power, densities were lower than at reference sites. No distinct local populations were identified.

Lake Whitefish and Round Whitefish Comprehensive Research Program

Part 1: University of Guelph and SON

This work between Saugeen Ojibway Nation and the University of Guelph focused on population discrimination, modelling, and entrainment effects.



Part 2: NSERC Collaborative Research Program with McMaster University and University of Regina

Federally co-funded research that examined thermal, chemical and radiological stressors on Whitefish eggs and juveniles. Over 550,000 Lake Whitefish and 40,000 Round Whitefish eggs were raised in controlled experiments and more than two dozen peer-reviewed papers were published.

2005-2010

Expanded Monitoring and Risk Assessment

Bruce Power expanded its monitoring programs and initiated risk assessments to better understand potential ecological impacts.

KEY FINDING Population modelling and field studies confirmed Whitefish were present near Bruce Power, but no distinct populations were identified that would be disproportionately affected by site operations.

2011-2017

Academic Collaborations & Experimental Research

To address remaining uncertainties, Bruce Power funded research with academic institutions and Indigenous Nations and Communities.

KEY FINDING Controlled laboratory studies improved understanding of thermal tolerance and ecological responses of Whitefish eggs and juveniles under a range of environmental stressors, which is used in thermal risk assessments.

Thermal Monitoring

Temperature loggers and Acoustic Doppler Current Profilers (ADCP) deployed to measure lake temperatures and currents. Data showed mean winter temperatures below 5°C and daily ranges typically under 3°C.

Thermal Plume Modelling

Simulations indicated that thermal plumes affected less than 30% of potential spawning habitats and were confined to nearshore areas.

Hatch Timing Analysis

Using empirical models, Bruce Power characterized hatch advancement related to thermal effluent near the site.

2012-2018

Application of Research to Site Specific Conditions

Bruce Power applied the scientific findings to real-world lake conditions through detailed thermal monitoring and modelling.



KEY FINDING Results were compiled in the 2018 report "Application of Scientific Research on Whitefish Thermal Tolerances to Temperature Regimes near Bruce Power," which concluded that thermal discharges posed no significant risk to Whitefish egg survival, development, or hatch timing.



Power Reactor Operating Licence (PROL) 2018–2028 Submission

Included comprehensive Whitefish research summaries and addressed concerns raised by Indigenous Nations and Communities and the Canadian Nuclear Safety Commission (CNSC).

Environmental Compliance Approvals (ECAs)

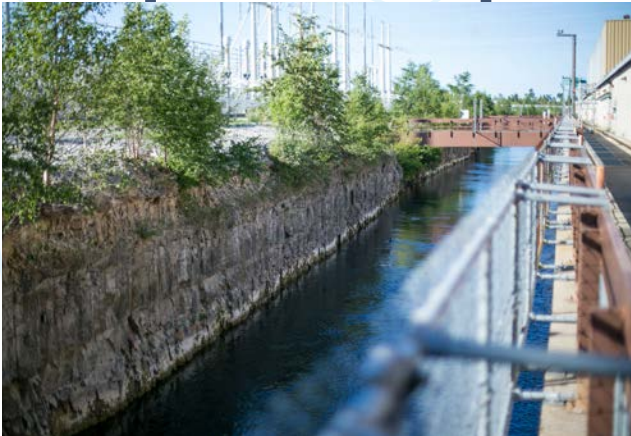
ECAs set temperature limits for effluent discharges to protect aquatic life. The basis for these limits was revalidated, informed by thermal monitoring data and thermal risk assessments.

Thermal Benchmarks, Trent University, funded by Bruce Power, NSERC Alliance, and Mitacs Accelerate

A three-year research program to develop methods to estimate species-specific thermal limits and tools to improve assessment accuracy and ecological relevance of risk assessments.

Long-Term Environmental Baseline

A multi-project initiative supporting cumulative effects assessments and long-term planning. Components include real-time monitoring (smart buoys, thermal loggers), paleolimnological research with York University to reconstruct historical lake conditions, and collaboration with the Chippewas of Nawash Fisheries Assessment Program and academic partners to establish a long-term system of monitoring sites that track temperature, water chemistry, and plankton communities.



2025 & beyond

Current Studies

New research will refine thermal risk assessments for heated effluent discharge.



2018–2025

Integration into Regulatory and Operational Frameworks

KEY FINDING Research findings were incorporated into formalized impact assessments and routine environmental risk assessment to support regulatory submissions, environmental approvals, and operational controls. These iterative bodies of work receiving regulatory acceptance support continued conclusions of no significant adverse environmental effects associated with operations.

Project Updates



Paleolimnology: Using Lake Sediments to Track Environmental Change

COLLABORATORS: YORK UNIVERSITY

START YEAR: 2024

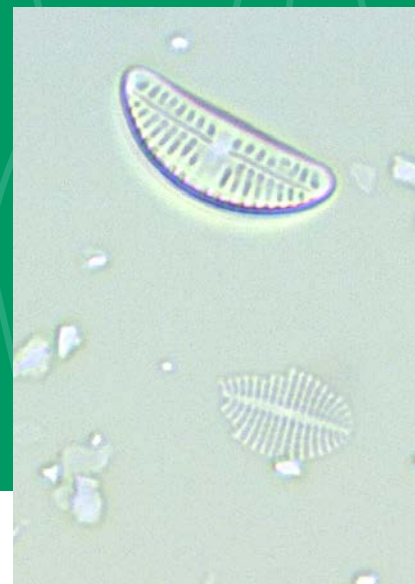
Many environmental changes in Lake Huron have happened gradually, over decades, and often before consistent monitoring programs were in place. This project uses lake sediments as a natural archive to reconstruct how the nearshore environment has changed over the past 100-200 years. This approach, known as paleolimnology, relies on the fact that layers of mud build up on the lakebed over time, with newer material settling on top of older sediment. This means the layers are often a faithful indicator of changes that have occurred.

In 2024, the team collected sediment cores in nearshore bays located a range of distances from Bruce Power. By analyzing these cores, researchers can track historical changes in water quality, biological communities, and environmental conditions. These records help distinguish between natural variation, regional pressures, and potential local influences.

KEY PROGRESS IN 2025

The first and most important step in a paleolimnological analysis is establishing a reliable chronology—the model for associating the depth of sediment in a core with the date range it was deposited. This can be a challenge for cores collected in the nearshore areas of large lakes, where sedimentation rates often can be erratic. In 2025, the research team made significant progress in this area, with four of the eight collected cores (including those collected in Baie du Doré and Stokes Bay/Greenough Harbour) providing strong, reliable dating profiles.

The team also advanced detailed laboratory analysis of the cores, including measuring their chemical composition and assessing the diatoms (single-celled algae) in the sediment. Diatoms have cell walls made of glass silica, which means they stay preserved very well in lake mud. Different species thrive under different environmental conditions, so by identifying which diatoms are present in a sediment layer, researchers can



make inferences about past changes to water quality, nutrient levels, and climate conditions.

In 2025, the team completed diatom analysis for the Baie du Doré core, covering a history dating back to the late 1800s. With the diatoms identified in this core, researchers can now compare changes in the diatom communities to the known timing of events in and around the Lake Huron area, such as construction and operation at Bruce Power and the introduction of invasive species such as dreissenid mussels, in order to infer the drivers of environmental impacts.

RESEARCH FOCUS FOR 2026

In 2026, the team will complete analysis of additional sediment cores. This includes diatom analyses of cores from Stokes Bay/Greenough Harbour, which will then be compared to the Baie du Doré diatom analysis results. This will allow a clearer comparison between sites and help identify whether observed changes are driven by local conditions or broader regional trends.

The results will provide a long-term context for understanding how Lake Huron has responded to environmental pressures, supporting future monitoring and decision-making.

RESEARCH TEAM AND CONTRIBUTORS

Faculty:

- Joshua Thienpont, York University
- Jennifer Korosi, York University

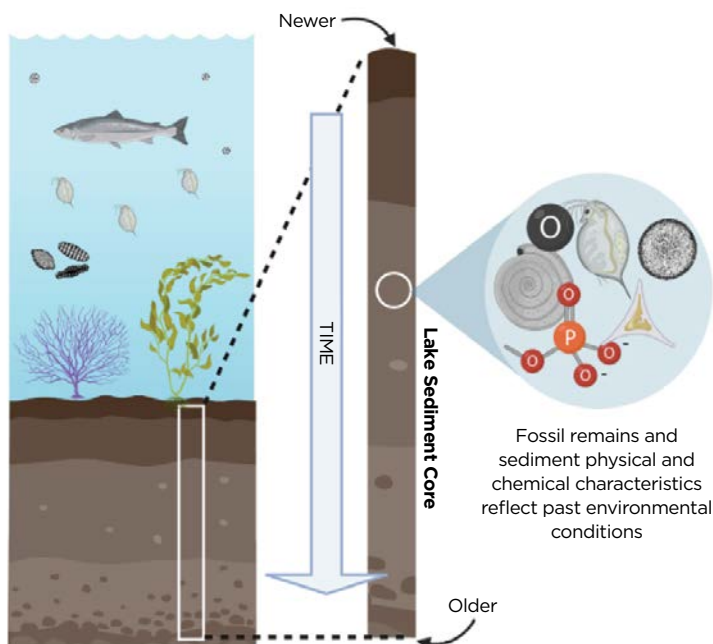
Undergraduate students:

- Vesta Tajik

SCIENTIFIC OUTPUTS IN 2025

Presentations:

- Tajik, V., Korosi, J.B., Thienpont, J.R. Assessing impacts of human activity and environmental change on nearshore locations in Lake Huron. Eastern Canada Paleolimnology Symposium, Sherbrooke, Canada. May 2025. *Awarded "best talk" award at the symposium.*





Refining Thermal Benchmarks for Fish

COLLABORATORS: TRENT UNIVERSITY

START YEAR: 2025

Bruce Power uses a once-through cooling system that draws in water from Lake Huron and passes it through condensers and heat exchangers to condense steam and cool equipment, then returns the water to the lake at a warmer temperature. The temperature of the discharge waters emitted from Bruce A and Bruce B are continuously monitored year-round, and the discharge points have thermal limits to mitigate effects to fish habitat and behaviour. Understanding how this temperature difference affects fish is an important part of Bruce Power's commitment to environmental protection and informs regulatory decision-making. Enhanced understanding of the effects of warm water on fish also helps researchers predict what will happen more broadly in the Great Lakes as the climate changes.

Fish species do not all respond to heat in the same way. Some species can tolerate warmer water very well, while others are more sensitive. Even within the same species, different life stages (eggs, larvae, juveniles, and adults) may have different preferred and tolerated temperatures. In many cases, the exact upper temperature limits are not known.

This project aims to improve how thermal benchmarks are assessed by developing more robust methods that account for uncertainty, missing information, seasonal changes, future climate conditions, and differences among fish species and life stages.

This work focuses on three areas:

1 - Updating temperature benchmarks

Researchers are reviewing and updating the thermal benchmarks used in Bruce Power's [2022 Environmental Risk Assessment](#) (ERA). A thermal benchmark is a temperature value used to help determine whether a fish may be at risk. Benchmarks can represent different types of biological limits, such as a temperature where survival is affected or growth rates begin to decline. Many of the existing values in the current benchmark tables came from literature reviews conducted many years ago. The researchers are now reviewing those values, incorporating information for additional species, and collecting new field data from fish near the Bruce Power site. This work will provide more accurate, site-specific information for future assessments.

KEY PROGRESS IN 2025

The team completed a comprehensive review of existing thermal tolerance data, tracing benchmark values back to original studies, assessing their quality, and updating them where needed using more recent and reliable sources. Missing data—particularly for sensitive early life stages—were identified and supplemented where possible using newer literature. Benchmarks were added for three additional species: Lake Sturgeon, Cisco, and Northern Pike.

Fieldwork was also conducted at the Bruce Power site to collect site-specific data on fish thermal tolerance. Fish were captured from both the Bruce A discharge area and nearby Baie du Doré (which has a different species composition and temperature than the discharge area) and tested to determine their upper thermal limits. This helps generate site-specific data rather than relying only on studies from other locations. The trials focused on Smallmouth Bass and adult Emerald Shiners, with plans to expand for a more comprehensive sampling program in 2026.

RESEARCH FOCUS FOR 2026

Field sampling will be expanded to include a wider range of species, including both adult and juvenile fish from the discharge area and Baie du Doré. The team will assess the upper thermal tolerance of the fish, and results will serve as site-specific benchmarks that can be directly integrated in the 2027 Environmental Risk Assessment.

2 – Improving how thermal thresholds are calculated

This work aims to improve how temperature thresholds are assessed by developing an updated approach that reflects the latest science and modern experimental practices.

The Maximum Weekly Average Temperature (MWAT) formula is used to determine thermal thresholds for fish in areas affected by thermal effluent. Currently, the MWAT formula uses a measure called the Upper Incident Lethal Temperature (UILT), representing a temperature that becomes lethal to fish over a longer exposure period. Because measuring UILT in experiments is lethal to fish, it has been replaced in more recent science with another measure called the Critical Thermal Maximum (CT_{max}), the temperature at which a fish loses normal body function under rapid (often +0.3°C per minute), controlled warming.

Researchers will explore how CT_{max} relates to other traits of fish, including growth performance at different temperatures, and whether this measure can be used instead of UILT to develop chronic benchmarks. They will also investigate differences between temperature-related characteristics of cold-water, cool-water, and warm-water species, and whether the MWAT formula should be tailored to reflect these differences.

KEY PROGRESS IN 2025

Researchers identified 20 species that have strong existing data on thermal biology. The species were selected because they have enough published information to help the researchers understand how different thermal traits are connected. The species include different thermal guilds (groups of species with similar temperature preferences) to allow for comparison between cold-, cool-, and warm-water fish. The team also developed a search protocol to guide the literature and data review. The team is using this data to build an improved model for temperature thresholds. In 2025, they presented the approach for using the new data to update the MWAT formula to Environment and Climate Change Canada.

RESEARCH FOCUS FOR 2026

With the search protocol complete, the team will next compile data on growth and upper thermal tolerance for the species identified in 2025. The data will be used to refine and redevelop the MWAT formula used to determine thermal benchmarks for fish.

3 – Experimental work on fish thermal biology

This work is designed to fill data gaps that are difficult to address through existing literature reviews. Thermal effluent does not always create a simple, constant exposure to an increased temperature: fish near a discharge area may move in and out of warmer water, or may experience temperatures that change over time.



Researchers are conducting laboratory experiments to determine how fish react to both steady and changing temperatures, including how these conditions affect early life stages, and how quickly fish can acclimate and adjust to warmer conditions.

One focus of these experiments is the relationship between agitation temperature and the Critical Thermal Maximum (CT_{max}) temperature. Agitation temperature is a behavioural measure. It refers to the temperature where fish begin to show signs of distress or agitation as water warms. This happens before CT_{max}, which is a physiological measure of the temperature where a fish loses normal body function. Researchers are seeking to understand whether agitation temperature is a more ecologically relevant indicator than CT_{max}, and whether it could be useful in including this metric in thermal risk assessments.

KEY PROGRESS IN 2025

In fall 2025, researchers collected wild Bluegill, Largemouth Bass, and Yellow Perch from the Otonabee River near Trent University. The bluegill and bass were used to test whether agitation temperature and CT_{max} are reliable, repeatable measures of heat tolerance, and whether the earlier behavioural response of agitation temperature might be a better indicator of ecological stress than CT_{max} alone.

Yellow Perch were used in a separate experiment on metabolic rates and CT_{max}. Metabolic rate reflects how much energy a fish uses. Understanding metabolism is important because temperature can affect energy use, growth, and overall performance.

RESEARCH FOCUS FOR 2026

Researchers will study how Yellow Perch and Smallmouth Bass embryos and larvae respond to high temperatures, helping refine benchmarks for the early life stages of these species.

They will also collect Yellow Perch from the area around the Bruce Power site throughout the season to assess how natural seasonal temperatures affect thermal tolerance. This will help determine whether wild fish become more heat tolerant as the lake warms throughout the year.

Additional experiments using Bluegill will examine how fish adjust to warmer conditions over time. Researchers will compare how fish respond to a stable ambient temperature of 20°C, a stable warm temperature of 25°C, and a fluctuating temperature between 22°C and 28°C. The team will measure the upper heat tolerance limit and the lower cold tolerance limit to understand how quickly fish acclimate to warmer conditions and how they respond to changes in their environment. This helps risk assessment move beyond static benchmark values and consider the variable conditions that fish may experience near a thermal effluent. This work will also help inform assessments of future climate-related risk: as Lake Huron temperatures are expected to increase over time, fish may experience cumulative warming from both broader climate change and localized thermal effluent.

RESEARCH TEAM AND CONTRIBUTORS

Faculty:

- Graham Raby, Trent University
- Fredrik Jutfelt, University of Gothenburg

Research scientists:

- Jacob Brownscombe, Fisheries and Oceans Canada

Postdoctoral fellows:

- Jeremy De Bonville, Trent University

Graduate students:

- Jessica Smuk, Trent University

Undergraduate summer student:

- William Grant, Trent University

Funding support:

- Natural Sciences and Engineering Council of Canada (NSERC) Alliance Advantage Grant
- Mitacs Accelerate grant

SCIENTIFIC OUTPUTS IN 2025

Presentations:

- De Bonville, J., Raby, G.D. Hot and bothered: Behavioural and physiological responses to warming in fish. Société Québécoise pour l'Étude Biologique du Comportement (SQÉBC). Montréal, Québec, Canada. November 2025.





Spotter Buoys: Tracking Lake Huron's Water Trends

As climate change continues to affect weather patterns and lake conditions, access to real-time water data remains critical for supporting public safety, advancing research, and providing early insight into environmental change. To support this need, Bruce Power purchased and deployed three smart Spotter buoys on Lake Huron in 2024, with an additional buoy added in 2025. The buoys continue to provide valuable data on temperature, waves, and currents along the Lake Huron shoreline.

Data from the buoys is shared with the open-access Seagull platform. Administered by the Great Lakes Observing System, Seagull brings together data from dozens of organizations, including universities, government agencies, and nonprofits, enabling scientists, decision-makers, and local communities to obtain data on lake conditions in real time.

KEY PROGRESS IN 2025

The Spotter buoys at Lorne Beach, Inverhuron, MacGregor Point, and Brucedale remained in operation throughout the 2025 open water season, continuing to generate high-quality data on lake conditions.

Understanding winter lake conditions remains an important knowledge gap, particularly for processes such as ice formation and cover, winter storms, and lake mixing. To help address this gap, the team tested winter deployment of an additional Spotter buoy.

In February 2026, the buoy stopped transmitting data after becoming trapped in ice, which likely covered its solar panel and disrupted power. The buoy was later

located once ice conditions improved in the spring and was successfully retrieved, but sustained damage from the weather conditions.

The trial provided valuable insight into the challenges of year-round monitoring in Lake Huron, particularly the risks posed by ice cover, storm conditions, and limited sunlight during winter months. Although another winter deployment is not planned at this time due to the damage, the experience highlighted a key limitation in current lake-wide monitoring: the lack of real-time data during winter conditions. This gap reinforces the importance of exploring other approaches to better understand winter processes, which play a significant role in overall lake dynamics.

In 2025, Bruce Power and the Nuclear Innovation Institute also contributed a \$1,000 donation to support the continued development of the Seagull platform. The platform plays a key role in making lake data accessible and supports broader monitoring efforts across the Great Lakes.

RESEARCH FOCUS FOR 2026

Spotter buoy data on temperature, waves, and currents will continue to be integrated into Bruce Power's environmental monitoring program and will support long-term lake health assessments. The team will also continue to explore opportunities to enhance monitoring, including evaluating new sensors and configurations to expand the type and quality of data collected during the open water season.



Effects of Sub-Natural Background Radiation Exposure

COLLABORATORS: NORTHERN ONTARIO SCHOOL OF MEDICINE UNIVERSITY, SUPPORTED BY NSERC

START YEAR: 2023

All life on Earth has evolved in the presence of low levels of natural background radiation. While high radiation doses are known to be harmful, recent research suggests that very low doses may play a role in maintaining normal biological function.

This project explores what happens when natural background radiation is almost entirely removed. By studying organisms in one of the lowest-radiation environments on the planet — SNOLAB, a deep underground research facility — scientists aim to better understand how radiation influences cellular health, metabolism, and long-term biological stability. Research findings have implications for radiation protection standards, fundamental biology, and space exploration.

KEY PROGRESS IN 2025

Researchers continued long-term experiments at SNOLAB using yeast as a model organism. Building on earlier work with dried yeast, the team studied hydrated, actively growing yeast cultures to determine whether they would also show reduced growth rates and metabolic activity.

The yeast was cultivated in liquid for four days, equivalent to roughly 100 generations. In contrast to the dried yeast results, the hydrated yeast showed no

significant differences in growth rates. Yeast grown on agar plates formed slightly smaller colonies than control samples, but the difference was not statistically significant.

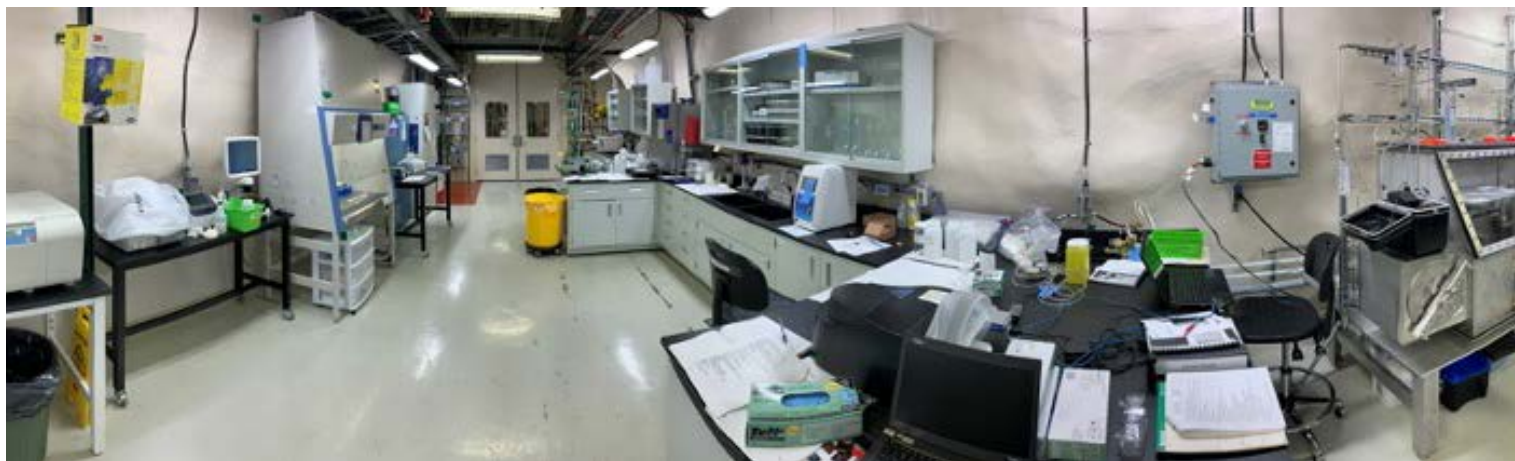
A major milestone this year was the launch of a new international collaboration involving multiple deep underground laboratories across the globe. Dried yeast samples will be incubated in up to eight of these underground facilities to test the study's previous findings.

RESEARCH FOCUS FOR 2026

In 2026, work on the global underground yeast project will continue to expand, with datasets expected from eight deep laboratories by the end of the year.

Researchers will continue to analyze the stored liquid and agar plate yeast samples to identify metabolic and genetic changes associated with growth in ultra-low radiation environments. The team will also prepare for longer-term experiments with liquid yeast (up to four months) by using automated bioreactor systems that allow yeast cultures to be maintained autonomously, making them suitable for sustained operation in SNOLAB.

Finally, researchers plan to restart experiments using human cell lines to better understand how prolonged radiation deprivation affects markers of cellular stress, DNA damage, and gene expression.



RESEARCH TEAM AND CONTRIBUTORS

Faculty:

- Simon J. Lees, Northern Ontario School of Medicine University
- Sujeenthara Tharmalingam, Northern Ontario School of Medicine University
- Christopher Thome, Northern Ontario School of Medicine University
- Douglas Boreham, Northern Ontario School of Medicine University
- T.C. Tai, Northern Ontario School of Medicine University

SNOLAB staff scientist:

- Michel Lapointe (former postdoctoral fellow)

Postdoctoral fellows:

- Rosette Tamaddon

Graduate students:

- Hayden Reaume
- Jaume Puig
- Taylor Laframboise (former research technologist)

Undergraduate students:

- Joey Hoffman (completed working on project in August 2024)
- Sana Malik (completed working on project in August 2024)
- Andree-Michelle O'Connor (completed working on project in August 2024)
- Dylan Reitze
- Alan Ripley
- Daniel Robinson

Research assistants:

- Eija Peuhkuri

Funding support:

- NSERC Alliance grant

SCIENTIFIC OUTPUTS IN 2025

Publications:

- Lapointe, M., Tattenberg, S., Bélanger-Champagne, C., Yen, S., Boreham, D.R., Hoehr, C., Thome, C. 2026. *A comprehensive radiobiological characterization of anhydrobiotic Saccharomyces cerevisiae*. *Astrobiology*. In press.

Presentations:

- Reaume, H. Investigating the role of natural background radiation in yeast. Oral Presentation. Ontario Provincial 3MT Competition. Toronto, Ontario, Canada. May 2025.
- Reaume H. Natural background radiation — current low-dose research at NOSM University. Poster Presentation. Northern Health Research Conference. Thunder Bay, Ontario, Canada. June 2025.
- Reaume, H. Analysis of sub-background effects on growth and survival in *S. cerevisiae* yeast. Poster Presentation. 71st Annual Radiation Research Society Meeting. San Juan, Puerto Rico, USA. September 2025.
- Thome, C. Life without radiation: studying biological responses in a deep underground laboratory. Oral presentation. 71st Annual Radiation Research Society Meeting. San Juan, Puerto Rico, USA. September 2025.
- Thome, C. Life without radiation: how studying biological responses in a deep underground laboratory can influence radiation protection standards. Oral presentation. 48th Annual Australasian Radiation Protection Society Meeting. Melbourne, Australia. October 2025.
- Reaume, H. Analysis of sub-background effects on growth and survival in *S. cerevisiae* yeast. Poster Presentation. Conex International Workshop on Advances in Radiation Biology, Radioecology, Epidemiology, and Low-Dose Radiation Risk Modelling and Communication. Ottawa, Ontario, Canada. November 2025.

Biological Effects of Radon Gas Exposure

COLLABORATORS: NORTHERN ONTARIO SCHOOL OF MEDICINE UNIVERSITY, SUPPORTED BY NSERC

START YEAR: 2023

Radon gas is a naturally occurring radioactive gas found in homes, workplaces, and underground environments. While high levels of radon exposure are known to increase lung cancer risk, there is still uncertainty about how lower levels affect the body and where meaningful health risk thresholds lie. This project aims to better understand how radon interacts with biological systems, providing evidence to support public health guidance and effective radon management policies.

KEY PROGRESS IN 2025

In 2025, the team reached a major milestone with the completion of a custom-built radon exposure chamber. The chamber was constructed in Australia based on a proven design, and will allow precise control of radon concentrations and long-term exposure experiments.

Researchers also completed multiple mouse exposure studies¹ using the original radon facility in Australia. In a long-term exposure study, mice were exposed to moderate radon levels for six months. The team collected tissue samples and analyzed the gut microbiome, which showed no major changes in microbial diversity. Next, they performed a shorter-term exposure study with mice exposed to higher concentrations of radon for durations between two days and four weeks. Tissue, blood, and microbiome samples were collected to examine the potential effects on the lungs, immune system, and other organs. Further analyses are ongoing.

RESEARCH FOCUS FOR 2026

In 2026, the new radon chamber will be shipped to Canada and installed at Northern Ontario School of Medicine's animal research facility in Sudbury. The chamber will undergo commissioning and is expected to be fully operational by the end of the year.

Ongoing studies in Australia will continue, including experiments testing whether a specialized antioxidant diet, which was previously shown to mitigate radiation-induced damage, can reduce radon-related biological effects. The research team will also continue to analyze samples from the tests completed in 2025.

RESEARCH TEAM AND CONTRIBUTORS

Faculty:

- Sujeenthara Tharmalingam, Northern Ontario School of Medicine University
- Christopher Thome, Northern Ontario School of Medicine University

- Douglas Boreham, Northern Ontario School of Medicine University
- Antony Hooker, University of Adelaide
- Dani Dixon, Flinders University

Research technologist:

- Dylan DeBellis

Postdoctoral fellows:

- Jake Pirkkanen (2026)

Graduate students:

- Aria Pourham
- Ashtyn Mowbray-Mcmillan

Funding support:

- NSERC Alliance grant

SCIENTIFIC OUTPUTS IN 2025

Publications:

- De Bellis, D., McEvoy-May, J., Kalnins, C., Puukila, S., Hooker, A.M., Boreham, D., Dixon, D.-L. 2025. Immunological and respiratory effects in a healthy rodent model after inhalation of low and regulated levels of radon. *Radiation Research*. 204(3):184-96.

Presentations:

- Thome, C. Biological impacts of chronic low dose radiation: mechanistic insights from SNOLAB and controlled radon exposure studies. Conexus International Workshop on Advances in Radiation Biology, Radioecology, Epidemiology, and Low-Dose Radiation Risk Modelling and Communication. Ottawa, Ontario, Canada. November 2025.



¹ All animal experiments were approved by the Laurentian University Animal Care Committee in accordance with the Canadian Council on Animal Care ethical guidelines for animal welfare.



Developing Novel Methods in Biodosimetry

COLLABORATORS: NORTHERN ONTARIO SCHOOL OF MEDICINE UNIVERSITY, SUPPORTED BY NSERC

START YEAR: 2023

Biodosimetry is the process of radiation exposure by examining biological changes within an organism.

This project focuses on microRNAs (miRNAs), which are small, non-coding RNA molecules that regulate gene activity. MiRNAs are highly stable in biological fluids, resistant to degradation, and detectable through minimally invasive techniques. These characteristics make them excellent potential tools for detecting and estimating radiation exposure.

A key area of focus is on identifying miRNA signatures specific to radon exposure, which is critical for assessing and understanding exposure risks.

KEY PROGRESS IN 2025

Early work on this project focused on validating miRNA as a radiation biomarker. A pilot study in rodents allowed researchers to identify specific miRNA patterns that changed in response to X-ray radiation. They identified several miRNAs that showed dose-dependent changes, including one particularly promising biomarker candidate.

In 2025, building on this earlier work, the team initiated radon exposure studies to directly compare biological responses to radon versus other radiation sources. Rodents were exposed to a high dose of radon² for durations between two days and four weeks, with plasma samples collected after each exposure. These samples are currently being sequenced, and a comprehensive analysis of radon-associated miRNA signatures is currently underway. The results from this dataset will provide the first comparison of miRNA responses between X-ray and radon exposure, and will support the identification of candidate biomarkers specific to radon exposure.

RESEARCH FOCUS FOR 2026

While current work is focused on using higher-dose radiation and radon exposures to establish initial biomarker candidates, the next phase of this project will refine and validate these biomarkers under lower and more environmentally relevant radon exposure levels. Researchers will also investigate how miRNA responses change over time, whether responses differ between males and females, and how long biological signals remain detectable after exposure.

RESEARCH TEAM AND CONTRIBUTORS

Faculty:

- Sujeenthara Tharmalingam, Northern Ontario School of Medicine University
- Christopher Thome, Northern Ontario School of Medicine University
- Douglas Boreham, Northern Ontario School of Medicine University

Research assistants:

- Cameron Hourtovenko

Graduate students:

- Ronan Derbowka

Undergraduate students:

- Asma Bilgasem
- Gizelle Lionel

Funding support:

- NSERC Alliance grant

2 All animal experiments were approved by the Laurentian University Animal Care Committee in accordance with the Canadian Council on Animal Care ethical guidelines for animal welfare.

SCIENTIFIC OUTPUTS IN 2025

Publications:

- Lionel, G.J., Derbowka, R., Sreetharan, S., Bel, J., Dougherty, J., Boreham, D.R., Tai, T.C., Thome, C., Lees, S.J., Tharmalingam, S. Plasma miRNAome profiling reveals candidate biomarkers for low- and high-dose whole-body ionizing radiation exposure. *Dose Response*. 2025. 23:15593258251391602. doi:10.1177/15593258251391602.
- Derbowka, R., Hourtovenko, C., Jameus, A., Dougherty, J., Narendrula, R., Levert, D., Valiquette, M., Pirkkanen, J., Lalonde, C., Bonin, P., Gagnon, J.D., Appanna, V.D., Thome, C., Tharmalingam, S.. Plasma miRNA responses to whole-body X-ray irradiation identify dose-dependent biomarker candidates. Manuscript in preparation.
- Derbowka, R., Peterson, J., Lionel, G., Mageau, E., Dickinson, N., Sreetharan, S., Al-Jumaili, Y., Yu, L., Lapointe, M., Reich, M., Reaume, H., Thome, C., Tharmalingam, S. A comprehensive literature review of miRNA and radiation biology studies. Manuscript in preparation.

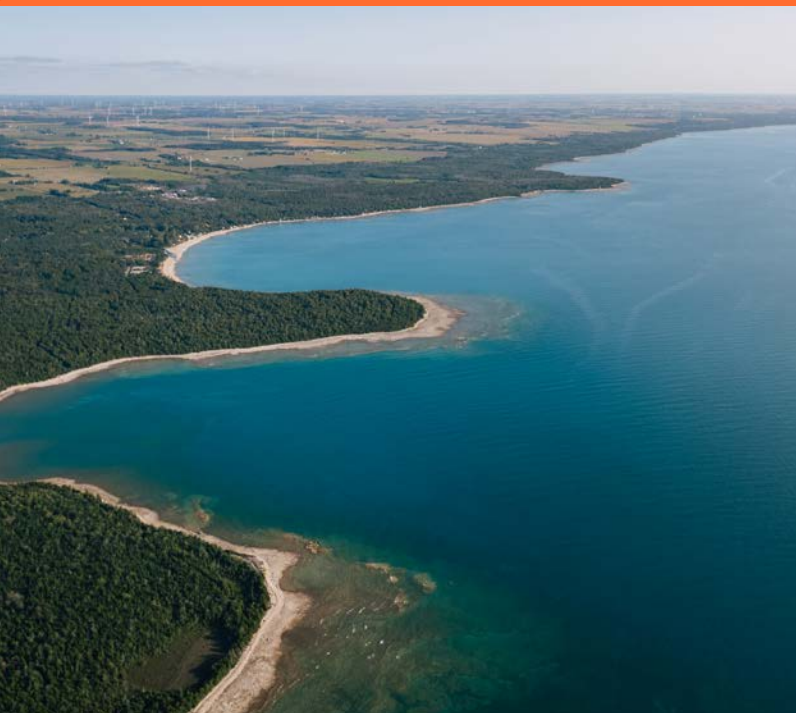
Presentations:

- Derbowka, R., Lionel, G., Sreetharan, S., Bel, J., Tai, T.C., Lees, S.J., Boreham, D.R., Thome, C., Tharmalingam, S. Identification of microRNA (miRNA) as biomarkers for radiation exposures. Oral presentation. Northern Health Research Conference. Thunder Bay, Ontario, Canada. June 2025.
- Derbowka, R., Lionel, G., Sreetharan, S., Bel, J., Tai, T.C., Lees, S.J., Boreham, D.R., Thome, C., Tharmalingam, S. Identification of microRNA (miRNA) as biomarkers for radiation exposures. Poster presentation. 71st Annual Radiation Research Society Meeting. San Juan, Puerto Rico, USA. September 2025.
- Derbowka, R., Lionel, G., Sreetharan, S., Bel, J., Tai, T.C., Lees, S.J., Boreham, D.R., Thome, C., Tharmalingam, S. Identification of microRNA (miRNA) as biomarkers for radiation exposures. Poster presentation. Conex International Workshop on Advances in Radiation Biology, Radioecology, Epidemiology, and Low-Dose Radiation Risk Modelling and Communication. Ottawa, Ontario, Canada. November 2025.



A Look Ahead to 2026

In 2026, Bruce Power is expanding its research program with several new projects focused on understanding Lake Huron's nearshore environment. These projects build on existing work and address key concerns related to ecosystem health and fish populations.



Sentinel Sites and Paleolimnology

COLLABORATORS: YORK UNIVERSITY, CHIPPEWAS OF NAWASH FISHERIES ASSESSMENT PROGRAM, SON COASTAL WATERS MONITORING PROGRAM

Building on the paleolimnology work outlined in this report, this project pairs historical analysis with long-term monitoring to better understand environmental change in Lake Huron. A network of sentinel monitoring sites (long-term locations used to track changes over time) will collect frequent data on temperature, water chemistry, and plankton communities. Combined with sediment core analysis, this approach will establish a strong baseline for assessing cumulative effects and understanding how nearshore conditions have changed over time, including habitats important for Lake Whitefish.

Trophic Hotspots and Telemetry

COLLABORATORS: UNIVERSITY OF GUELPH, CHIPPEWAS OF NAWASH FISHERIES ASSESSMENT PROGRAM, SON COASTAL WATERS MONITORING PROGRAM

This project aims to identify and understand “trophic hotspots” — areas of high biological productivity that support feeding, growth, and energy flow through the food web. Researchers will examine how factors such as thermal plumes, currents, and habitat features influence these areas. Bruce Power will support this work by providing data from an acoustic array that will track tagged fish species including Gizzard Shad, Smallmouth Bass, Lake Whitefish, and Sturgeon, enabling detailed analysis of fish movement and habitat use near site infrastructure. The results will improve understanding of fish movement and help identify regions that are especially important for fish habitat and overall ecosystem resilience.

Nutrient Limitation and Food Web Dynamics

COLLABORATORS: UNIVERSITY OF GUELPH, CHIPPEWAS OF NAWASH FISHERIES ASSESSMENT PROGRAM; SUPPORTED BY MITACS

How does nutrient availability (particularly phosphorus) influence plankton communities and the broader food web? This project aims to answer that question by conducting laboratory experiments examining how changes in nutrient levels affect the quantity and quality of plankton. They will also investigate how this in turn impacts the growth and survival of larval Lake Whitefish.

Nutrient and Plankton Monitoring for Whitefish Rehabilitation

COLLABORATORS: CHIPPEWAS OF NAWASH FISHERIES ASSESSMENT PROGRAM

Lake Whitefish (dikameg in Anishinaabemowin) play an important role in SON culture, economy, and food sovereignty. This project fulfills a commitment under Bruce Power's Fisheries Act Authorization and will support sampling in Stokes Bay, an important Lake Whitefish nursery area, to better understand nutrient conditions and plankton communities. The work will establish a strong baseline dataset and will be closely integrated with related University of Guelph research. Together, these efforts will support future planning and potential Whitefish rehabilitation efforts led by Saugeen Ojibway Nation.





Synthetic Whitefish Egg Entrainment

COLLABORATORS: UNIVERSITY OF GUELPH,
CHIPPEWAS OF NAWASH FISHERIES ASSESSMENT
PROGRAM; SUPPORTED BY MITACS

This project will test whether synthetic (artificial) eggs can be developed for use in future studies that could quantify uncertainty in entrainment sampling protocols for cooling water systems. By establishing the feasibility of this approach, the project will contribute to addressing a key concern identified by Saugeen Ojibway Nation on early life-stage impacts from plant operations and will help inform future mitigation strategies.

eDNA Monitoring

COLLABORATORS: UNIVERSITY OF TORONTO;
SUPPORTED BY MITACS

A powerful method of tracking fish populations that has emerged in the last decade is known as environmental DNA (eDNA) assessment. By examining the traces of DNA shed by fish in the water (such as mucous, feces, urine, gametes, and skin cells), researchers can determine the relative abundances of different types of species. This project will investigate the use of eDNA for improving Bruce Power's entrainment monitoring by developing and testing new sampling methods and comparing eDNA results with existing monitoring data to ensure accuracy.

Wave and Ice Modelling

COLLABORATORS: QUEEN'S UNIVERSITY, TEXAS
A&M UNIVERSITY

Waves and ice play a major role in shaping nearshore habitats, yet these processes remain challenging to model. Researchers will use advanced modelling techniques, including machine learning, to better understand how these physical forces influence sediment movement, habitat stability, and temperature patterns. The results will help fill an important gap in winter science on the Great Lakes.



177 Tie Rd., Tiverton, Ontario, Canada N0G 2T0

www.brucepower.com